

REVIEW

Tertiary Prairie Grasses and Other Herbs from the High Plains. By MAXIM K. ELIAS. Geological Society of America, Special Papers, number 41. 176 pages, 6 tables, 7 plates. 1942.

The student of living plants who judges from the title of this monograph that it deals entirely with the fossilized hulls of plants long dead is due for a pleasant surprise. Dr. Elias begins his work with an exhaustive review of modern research in all phases of agrostology, in which he refers not only to the classical authorities on the subject, but in addition to several valuable and little known recent contributions to the ecology and morphology of grasses. He then gives a remarkably thorough description of the morphology and taxonomy of the tribe Stipeae, to which belong nearly all of the fossil grasses described by him. The modern genera and many of their species are carefully treated, and many important new diagnostic characteristics are described. These result from a careful comparative study and a penetrating analysis of one of the most complex and diverse series of structures in the grasses, the fruiting lemma or hull of the Stipeae.

Based on this study, Dr. Elias presents a new division into sections of the genus *Stipa*, one of the largest and most diverse of the entire family Gramineae. The nine sections recognized by him may have to be somewhat modified, and more may have to be added as our knowledge of the details of the morphology of the various species becomes more complete, but there is no doubt that Dr. Elias' system is by far the nearest approach to a natural one that has yet been achieved. It will be a fundamental basis for all future work on *Stipa*. Every botanist interested in the grasses should read carefully the first part of this work.

After having spent 72 of the 146 pages of text on this study of living grasses, Dr. Elias occupies a large part of the remainder with a careful description of the large series of beautifully preserved fossil fruits of Gramineae and Boraginaceae, which he has discovered and collected during the past ten years on the plains of Nebraska, Kansas, and adjacent states. Their age, as determined by a careful analysis of the geological formations in which they occur, is late Tertiary, principally late Miocene to middle Pliocene. Most of them are referred to the fossil genus *Stipidium*, considered closely related and directly ancestral to the modern *Stipa*. There are, however, a number of species of the anomalous fossil genus *Berriochloa*; one of another extinct genus, *Paleoeriacoma*, perhaps ancestral to the modern *Oryzopsis hymenoides*; and one of the modern genus *Nassella*, of which all of the modern species are confined to temperate South America. This last discovery is obviously of great importance to students of the modern plant geography of the Americas. In addition to these representatives of the tribe Stipeae, the author describes the fruits of one

fossil species of *Panicum*, one of *Setaria*, and refers to the new fossil genus, *Clementsella*, a fossil species previously described as *Stipa laminarum*. In the Boraginaceae, five species are included, two of them belonging to extinct genera related to the modern *Anchusa* and *Lithospermum*, and three to the modern genus *Krynitzkia*. The original descriptions of many of these species were published by Dr. Elias in earlier papers.

The collection of fossils of the tribe Stipeae is, so far as this reviewer is aware, much the most complete of any series of herbaceous Angiosperms known from any locality. What is more important, the part preserved, the fruiting lemma, is precisely the one which shows the most valuable diagnostic characteristics for the modern species of the tribe. For these reasons, Dr. Elias' contribution to our knowledge of the evolution of this group is unique.

With such fine evidence at hand, Dr. Elias is naturally tempted to reconstruct the phylogenetic history of the entire tribe. It is in this phylogeny that he is on his weakest ground. It is based on two assumptions. In the first place, nearly all of the fossils are referred to an extinct genus, *Stipidium*, although on the basis of the parts preserved they are indistinguishable in all characteristics except size from fruiting lemmas of modern species of the genus *Stipa*. The fossil genus is separated from the modern one because its awn is believed not to have been indurated as are the awns of modern *Stipa* species. This is because no awns or parts of them have been found in the fossil deposits, although thousands of lemmas are known. However, this is only indirect evidence, and one cannot be certain that awns like those of modern *Stipa* species would become preserved and silicified as are the lemmas. In this connection, it is significant to note that although the stems and leaves of *Stipa* are often rather hard and tough, these have not been preserved either. There is, therefore, only indirect evidence that *Stipidium* and *Stipa* are distinct genera, a conclusion which forms the basis of Dr. Elias' belief, as expressed in the chart at the end of his work, that the modern genus *Stipa* originated as recently as the end of the Pliocene epoch. This hypothesis does not agree with evidence from the distribution of living species of the genus, since *Stipa* is represented by numerous diverse species in all continents except Africa, and there are affinities between species which indicate past inter-migrations, not only between Eurasia and North America, but also between North and South America and between South America and Australia. The latter connection, which appears to indicate a former Antarctic distribution for certain species of the genus, is strong circumstantial evidence that *Stipa* was already well developed in the middle or even the early part of the Tertiary period.

The second assumption, that the species found in the fossil record of the high plains demonstrate the principle lines of evolution in the tribe Stipeae, is equally open to question. At present, only a small proportion of the species of this tribe occur in steppe or prairie grass formations, and these do not include the species which are the least specialized morphologically, and might therefore be looked upon as the most primitive modern forms. Furthermore, many of these more primitive species have only weakly indurated lemmas, which would probably not be preserved as fossils. In addition, the author gives convincing evidence of the migration of some of the species into the area, as well as their sudden disappearance, apparently through migration away from the region of the fossil deposits. The reader, therefore, cannot help thinking that much of the evolution of the tribe Stipeae during the Miocene and Pliocene periods took place outside of the Great Plains area, and that some of the more recent fossil species evolved not from earlier species of the same region, but from species living elsewhere. This seems particularly likely in the case of the two Pliocene species *Paleoeriocoma Hitchcocki* and *Nassella amphora*. For this reason, some of the evolutionary trends postulated by Dr. Elias must still be regarded as hypothetical and based on indirect evidence. It is to be hoped that paleobotanists will make discoveries similar to those of Dr. Elias elsewhere in the world, so that a nearer approach to a complete distributional picture of the fossil members of this tribe can be obtained.

There are, unfortunately, a few minor nomenclatorial discrepancies in the monograph. For instance, *Stipidium* sect. *Parastipidium* (p. 87) is recognized as a separate genus in the chart, Plate 17. Similarly, *S. variegatum* modification *Dartoni* (p. 83) is referred to on p. 116 as *S. Dartoni*, while *S. Schereri* mut. *marslandense* (p. 88) appears in the chart as *Parastipidium marslandense*. These errors apparently reflect the natural changes of opinion which the author underwent during his pioneer work on this difficult group, and could perhaps have been avoided by more careful editing.

The student of living plants can only hope that this outstandingly careful, painstaking, and original monograph is the forerunner of still further discoveries by Dr. Elias along the same lines, and that other paleobotanists will follow his lead, and give us a more and more complete fossil record of at least this group of herbaceous angiosperms.—G. L. STEBBINS, JR., Division of Genetics, University of California, Berkeley.